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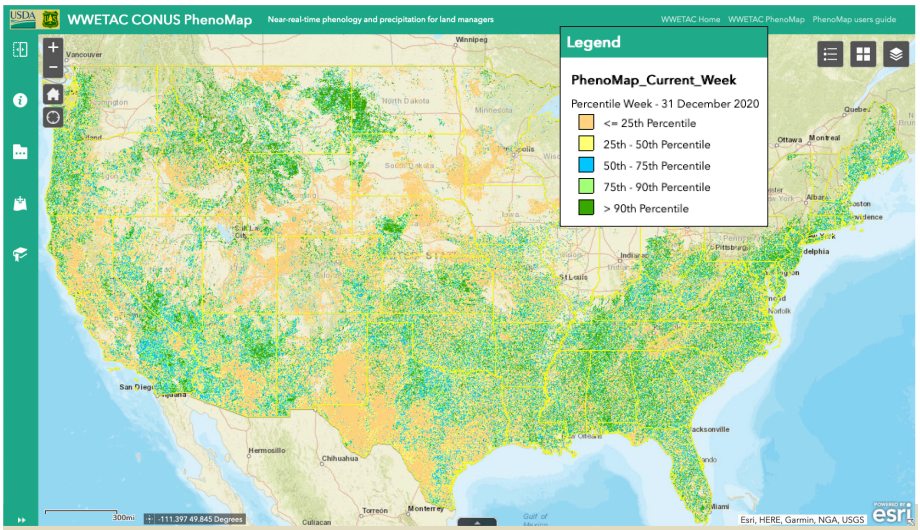
Timing It Right: Maximizing Range Management Effectiveness with PhenoMap

Timing is everything, especially when it comes to the complex ecological interactions between plants and the environment. For range managers concerned with maintaining the integrity and productivity of rangelands, it is critical to monitor the seasonal development and condition of grasses and other vegetation on which cattle graze.

PhenoMap is a new Web-based tool that managers can use to assess the production and location of high-quality forage. It uses satellite imagery to address the need for near-real-time information about plant life cycle events over large spatial areas. PhenoMap was jointly developed by researchers at the Forest Service's Western Wildland Environmental Threat Assessment Center, Pacific Northwest Research Station (PNW) and Rocky Mountain Research Station (RMRS).



PhenoMap is a Web-based tool that displays weekly land surface phenology map layers, including current greenness compared to historical greenness, cumulative precipitation, and accumulated growing degree-days. The tool is available on the Western Wildland Environmental Threat Assessment Center website.

"Our remote sensing tool can help prioritize management of rapidly degrading resources across the landscape, in near real time," says Nancy Grulke, a PNW research ecologist with the project. "Tracking resource quality from week to week with imagery can not only support management decisions with empirical evidence, but also provide a visual tool for communication with landowners."

Near-real-time information across large areas

PhenoMap gets its name from phenology, the study of seasonal events in a plant's life cycle. The timing of budding, flowering, and fall senescence can influence management decisions and the effectiveness of implemented actions.

"Phenology is tightly linked with production," explains lead tool developer Charlie Schrader-Patton (PNW). "Weekly assessments of forage development at the landscape scale inform the phenological trajectory of a pasture. For example, if a pasture in an allotment is significantly lagging in development after a cold, wet spring, perhaps that pasture is not ready for turn out."

As forage productivity and quality changes throughout the season, PhenoMap can provide information on those changes as they occur so that land use decisions can be adapted to meet management objectives. "PhenoMap can track the onset of drought conditions as grassland

vegetation slows production and dries out," says RMRS research ecologist Jacqueline Ott. "Managers who are responsible for large land areas can use PhenoMap to provide a comprehensive snapshot of conditions in their local areas as well as at the regional level. With this information, they can identify and prioritize pastures or larger areas of concern as drought develops across the landscape."

Satellite data validated by an on-the-ground camera network

PhenoMap uses image data from the Moderate Resolution Imaging Spectroradiometer (MODIS) satellite sensor. These data are processed to produce a map of each week's land cover "greenness" (based on the Normalized Differential Vegetation Index) that is displayed in a Web browser application accessible on personal computers and mobile devices. PhenoMap also provides weekly precipitation estimates from the National Weather Service, accumulated growing degree-days from the USA National Phenology network, and reference boundary layers, all in a self-contained application that does not require any geographic information system (GIS) software.

Schrader-Patton, Grulke, and Ott validated the satellite-based information by using photos from more than 50 on-the-ground cameras in the PhenoCam network, located across a variety of vegetation types and ecoregions. They found the tool to be most effective at providing information on grasslands, shrublands, and deciduous broadleaf and mixed forests, but less effective for evergreen conifer forests.

"Range managers traditionally rode horses and now they drive vehicles to survey resource quality," says Grulke. "They know and regularly communicate with landowners and other agency managers to monitor and adjust the use of natural resources. Little can replace this human aspect. PhenoMap offers an 'eye-in-the-sky' monitoring of resource availability and quality at the landscape level that can help managers make near-real-time decisions even when they're unable to survey an area in person."

Seasonal PhenoCam images of the Prairie Peninsula National Ecological Observation Network (NEON) site, Konza Prairie Biological Station, Kansas. These grass growth and senescence changes are captured by PhenoMap. (Photos courtesy of the PhenoCam network).

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Nancy E. Grulke is a research ecologist with the Pacific Northwest Research Station.

Jacqueline P. Ott is a research ecologist with the Rocky Mountain Research Station.

FURTHER READING

Schrader-Patton, C.; Grulke, N.; Ott, J. 2020. Monitoring land surface phenology in near real time by using PhenoMap. Gen. Tech. Rep. PNW-GTR-982. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 98 p.

Reeves, M.C.; Hanberry, B.B.; Wilmer, H.; Kaplan, N.E.; Lauenroth, W.K. 2020. An assessment of production trends on the Great Plains from 1984 to 2017. Rangeland Ecology and Management. doi:10.1016/j.rama.2020.01.011.

Browning, D.; Snyder, K.; Herrick, J. 2019. Plant phenology: Taking the pulse of rangelands. Rangelands. 41(3): 129–134. doi:10.1016/j.rala.2019.02.001.

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